Validation of a non-invasive model for predicting long bone loading

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Abstract:
Functional interpretation of limb bone cross-sectional geometry depends upon knowledge of the magnitude and direction of habitual loading. Quantification of bone loading has only been possible using invasive, in vivo strain measurement, but a non-invasive alternative is highly desirable. This study tests a new biomechanical model designed to predict bone loading conditions non-invasively from 3D kinematic and ground reaction force data. The model is tested using simultaneous strain, ground reaction force and kinematic data obtained in vitro from an aluminum limb prosthesis, and in vivo from measurements on sheep metatarsals. Preliminary results suggest that the orientation of the neutral axis of bending, and, to a lesser extent, its position on the bone cross section, can be determined from the non-invasive force and kinematic data. With further refinements, this model will be used to predict the orientation of bone bending in distal limb segments and the relative amount of bending vs. compressive forces that the limb sustains. Such information will aid in more accurately relating bone cross-sectional geometry to locomotor behaviors, particularly in taxa such as humans where in vivo strain measurements cannot be obtained